Menlo Park Notebook #82 [N-80-03-15]

This notebook covers the period March-July 1880. Most of the entries are by Francis Upton. There are also occasional entries by Charles Batchelor and probably by Francis Jehl and Charles P. Mott. Most of the book consists of notes, calculations, and drawings relating to generators and motors, along with tests of these machines conducted with dynamometers, electrometers, and calorimeters. There are also photometer tests of lamps, notes on fuses, and a list of lamps for the steamship Columbia. The label on the front cover is marked "Upton." The book contains 282 numbered pages.

Blank pages not filmed: 144-145, 198-199, 226-281.

No 82

Thorkelson Dennis Patent

Wm Smith

1

$\frac{1}{2}$ surface $\frac{2}{3}$ loss

$\frac{1}{4}$ surfaces $\frac{4}{9}$

$\frac{1}{8}$ $\frac{8}{27}$

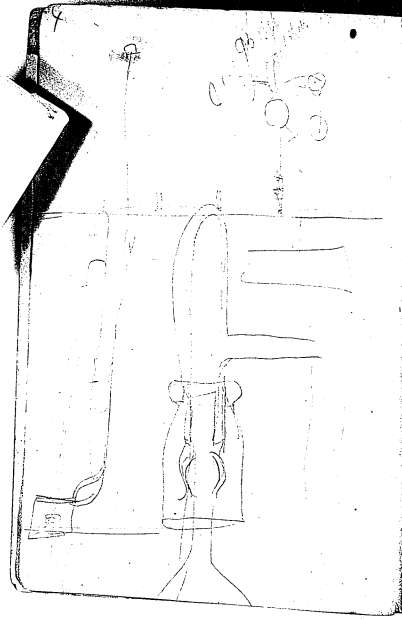
LIBRARY OF THE

BOARD OF PATENT CONTROL,

120 BROADWAY, NEW YORK.

GENERAL ELECTRIC.

Sept, 1896.

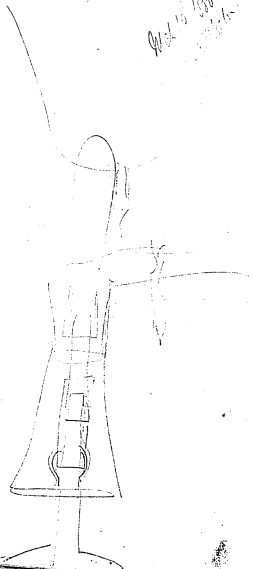


1 ft of ~~iron~~ iron weighing 1 grain has a resistance of 1.0997 Ohms at 0° F
1.16634 " at 60° F

Iron 9 lbs to yard,
1000 feet of.
3 lbs to foot
21.000 grains.

21000) 1.09700 (.00094
84000
13700

21000) 1.16340 (.0000553
105
113
105
74



.00005.53 Ohms per foot

1000

.0553 Ohms per 1000 ft.

5 1/2 Ohms

100

16 ~~[illegible]~~

5.53

9

16 ~~[illegible]~~

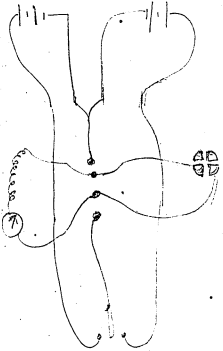
16 | 49.77

45

17

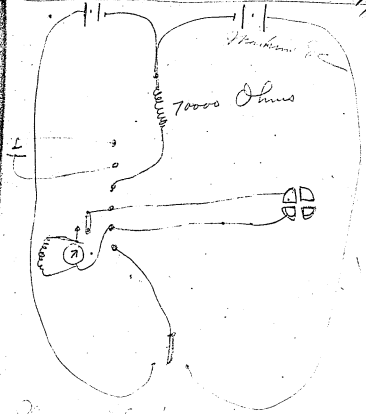
3.

Electrometer



This is no good [illegible]
reversing it would [illegible]
short O want [illegible]
used

Electrometer



Plan electrometer
Galvan. Cane circuit

925.
971
1896
990

925.
1045
1970.
985.

985
990
985
985
985
5
985

83
[illegible]
52

[illegible] of Prony

Mean R. [illegible]

Edison
Averag Wt. 985 lbs

Test of Prony
and Edison April 2, 1880.

(2, P. M.) Prony.
Prony shaft making 1163. R. in 2. min.
Edison. 985, 950. (2, 10. P. M.)
1,235. Mean 990.
(2.13. P. M.) Prony shaft making 1161. R. in 2. min.
(2.15) (2.15) (2.17½) (2.19½)
Edison 935. 1,125. 925. 18½.
985
36, lbs, boiler pressure 2, 15. P. M.
Bad vibration of scale beam, Edison.
33. lbs. boiler pressure 2.17. P. M.
Prony shaft making 1130. R. 2 min.
29. lbs. boiler pressure 2,20. P. M.
(2.21½) 945. Mean 985.
Edison 1025.
27. lbs. boiler pressure 2,21. P. M.
2,23. "
25 lbs. " " "
Stopped engine at 2.23.
Test on Prony.

— over —

14

955
875
1830
915

960
865
1825
914

870
951
1821
910

925
890
1815
907

889
957
1846
912

866
950
1816
908

915
914
910
912
908
67
911 lbs

985
911
174 lbs gain
37

5.25
5.25
5.25
5.25
6
5.75
6.25
45.50
57

557

Pony & Edison Test. continued. 15

started engine 2.30. P.M. with 22. lbs. boiler pressure

	Edison	955.	875 (2.35 c) (2.35 f)	960. (2.40) 865.
(2.35)	Pony.	12 ft.	5 1/4 lbs.	in addition to scale
(2.36 c)	"	12. "	5. "	" " "
(2.38)	"	12 "	5 1/4 "	" " "
(2.43.)	"	12. "	5.4. "	" " "

2.42 Pony shaft making 565. R.P.M.
2.45 " " " 550. R.P.M. } MEAN 557.

2.43.	Edison.	870.	(2.45 c) 951.	(2.45 f) 865. (2.50) 950.
2.43.	Pony.	12 ft.	5 3/4 lbs.	
2.45	"	12. ft.	6. "	
2.46.	"	12. ft	6 "	
2.47	"	12 ft	5.2. "	2.50 (2.50)
2.47	Edison	865.	(2.55) 953.	866. 950.

2.48 Pony shaft making 554. R.P.M.
2.49. Pony 12 ft. 5 3/4 lbs.
2.50. " 12 ft 6.4 "
Pony shaft making 557. R.P.M. 355. P.M.

Prony & Edison. tests concluded

2.57. Main shaft making, 360 R, 2, minutes
3.00 " " " 183. R.P.M.
3.02½ " " " 181. R.P.M.
3.05. " " " 183. R.P.M.
average 182

Data page 250 Book 41

Corrected size pulley 10.92

In timing the shaft the timer may have slipped as there was a very bad centre.

Wt scale 5 lbs 6½ oz 5.4 lbs may be wrong as it was weighed in store and weight remembered by Johnny

10.92
181
1092
8730
1976.52 speed

1976
37
13839
5931
73149 ft lb

537
34
111

536 rev 16)66
34
17

1115
536
1651

Edison 73 149
Prony 73 992

29

565
165
2825
3390
565
93225
7 8 6 4 3 ft. lbs.

945
945
945
9

55
16
3336
556
8896
3
26688 ft. lbs.

Edison

1475
565
88500
7375
83375
56
41866
24750
29915

Edison & Porry Dynamometer tests 2 Apl. 2.d 80. 21

TIME	
3.46.	Porry 16½ ft. 2 lbs.
"	" shaft making 565 R.p.m.
3.48	" 16½ " 3. "
3.51.	" shaft making 556. R.P.M.
"	" 16. ft. 2 lbs.
"	Edison 942. 943½. 943½.
3.53.	Porry shaft making 560.
"	Porry 17 ft. 3 lbs.
"	Edison 942½. 945. 946.
3.55.	Porry shaft making 552. R.P.M.
"	Porry 17 ft. 3 lbs.
"	Edison 946. 945. 945.
3.57.	Porry shaft making 560. R.P.M.
"	Porry 34.4.3½ lbs.
"	Edison 945. 946.
4.	

Over

5.9
7.25
5

5.9
4.25
7.65
12
1933
765
11586
55.2
2316
5790
5790
33921.6
28692
55829 - Pinney

1992
3
3976
5976
62772
31372
68720
34360

7.13
52

1992
3
5976

29

Continued.

Time	
4.02.	Pinney 17 ft. 7.4. lb
"	Pinney shaftmaking 510. R.P.M.
"	Edison 892. 892. 892.2.
4.04.	Pinney 12. ft. 6.2. lb
"	Pinney shaftmaking 542. R.P.M.
"	Edison 892. 892.2. 893.
4.06.	Pinney 12. ft. 8.2 lb.
"	Pinney shaftmaking 560 R.P.M.
"	Edison 890. 889.
4.08.	Pinney - ft. 44 - (900.)
"	Pinney shaftmaking 552 R.P.M.
"	Edison 913, 911. 913.
4.11.	Main shaft making 152 R.P.M.
4.12.	" " " 7183 "

26688
28560
28210
28910
112368
28092

945
6925
525

1092
1825
596 6

564
6.5
11.9
548

1093
555
1648
2186

Average of Prony before load 28092 ft. lbs.

Average Edison 945 lbs

One test

Edison 52.316 ft lbs

Prony 50.262

2nd Edison 56,055

Prony 63.643

3rd Edison Extremes 31.372
34.360

Prony 35.829

560
12
1120
560
6720

8.25
5.4
13.65
72
[illegible]
9555
5172
71[illegible]
[illegible]
[illegible]

Eleven 165

1002
165
5460
326
3972
[illegible]

[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

Electrometer

4 cells [illegible] for
[illegible]

36 R 47 R
36 R 46 R
[illegible]

4 cells connected [illegible]
[illegible]

46 R
47.5 R
46 R
0 adjusted 45 R
45.5 R

Amalgamated Zn
pure Zn + Cu solution
Siphon

Left	Right
47.5	47.5
47	47

Zinc amalgamated Zn
pure solution

46.5
46

Standard cells with
10 grams cup

46 R 46.5 L
46.5 L 46

Unamalgamated commercial

47 L 46.5 R
46 R

Opposed cells

In standard 600 less possible than amalgamated commercial

Standard [illegible] than [illegible]

Standard 3 0 0 less than amalgamated zinc

Standard 90 weaker than

One cell showing the effect of the [illegible]

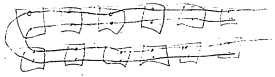
The standard in good condition a little [illegible]

Test machine

Resistance of coil

174 Ohms warm

room



1st Power required to drive machine magnet off circuit fuses

2 end Power required to drive the machine magnets closed

About 2.5 per H. P. in circuit
1.5 per H. P.
6 per H. P.
3 per H. P.

At the same time notice the E. M. F with circuit open

3rd Power required
to drive machine
circuit closed.
Magnets 5 per H.P.
1 per H.P.
6 per H.P.

~~[illegible]~~ make tests with
6 Ohms in color and
1.74 in color depositing
cell in circuit
Electro hydrometer
1/4 Ohm
Depositing cell
and voltameter in
same circuit

Make galva ~~[illegible]~~ so as to be about three marks per Volts and measure total Volts then so as to be about ten per Volt and measure Volts around E.D. 1/10 Ohm and depolarizing cell.

Plate I
Nt of C ~~582.95~~ Gm
582.9

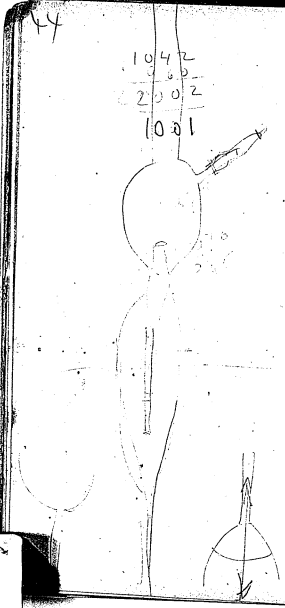
Plate II 621.18 G

April 6, 1880.

The Resistance (12 ones in hundredth au) was 226 ohms
(20 ones = 206 × 2.05)
~~Magnet 105~~
on the magnets 148.

On Edison's Dynamo 995
Extreme 1025
1025 + 963 = Mean 999
another extreme 942 (The magnet was on this) Magnet of one
extreme 1040

1042
1.05
2002
1001



Mean 996.5 another
extreme 960 = mean of both
extreme 1001.

Magnet on
another extreme 945
Mean 951
[illegible] 1.87 — 1.88
another extreme 1031
Mean of both extremes 988
another extreme 945
~~[illegible] 4.10~~ 5. P.M.
Brushes off magnet on
extreme 1050
extreme 948 [illegible]
Mean 991.5 [illegible]
extreme 1023

10.

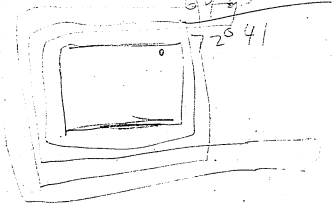
Temp air 69.35 F

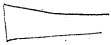
Temp H_2O 66.25

.3 8

34.3

72° 41

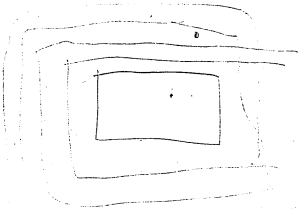




48

59

216
59
1944
1080
127.4 v Volts



5-35

49

20 cells = 50

Machine 295.

Edison

975 Wagner on

5-40 commenced

Machine current

255

Around Color 183

Running 847 Stopped 5-46.

875 Temp 42.0 75.9 F

977 Speed shaft

183

185

28) 176

176) 28 (22222

152

280

168

3.1673

222 2.2225

122 2.2222 6

114

204 000

123) 255

169000

255

845000

845

123) 366

649

4000

Wt Velat and stirrer 29 lbs

200
29
171

775
171
775
5425
775
6) 132525
22088

73.9
66.25
7.65
775
3825
5355
5355
5928.75
171
5928

$1496
5928
6) 10368 8
168948 ft. lbs.
22088
146860 ft 72°.97

Calor

Dynamometer
52° 10'

No. 1 5551

No. 2 615.41

5551
5520
5.770
10 970
6 5.555
1.2 55
10970
6 54555
19,5 .9140 46 Nelson
756
1340
1290
550

621.15
615.41
5.70

~~200~~ 183

85

50/20 X 1.08

2.7)183(67.7 Wb

210

189

21

44.3 1.6464

Imp 1.7 = 9.7595

67.7

38.9 Webers

.00373 Ohms coil

Resistance of machine

.14 Ohm

6 wires in multiple are

75 coils in machine .28 Ohm

each coil $\frac{.28}{75}$

75) .28000 = .373

225

500

525

250

.00373 Ohms in each coil

since the wires are in multiple with there would be

from the resistance

of each armature $\frac{.00373}{6}$

.0149 = Ohm

In each coil there is

an average $\frac{130}{75}$ Volt.

75) 130 (1.73 Volts
75
550
525
25

[illegible] 4 inches

[illegible] .002
[illegible] .15
.002 inch

1.73 volts from

the [illegible]

$\frac{4.11}{6} =$ [illegible]

[illegible]

16,[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
102 [illegible] inches

.02

[illegible]

Friction on pulley K 3

150 lbs drag

[illegible]

[illegible]

[illegible]

[illegible] for [illegible]

2640) [illegible] (1.25 lbs

[illegible]

125
.44
81

15.0

66

1039
996
2)2035
1017

33
8
264
15%
1320
264
2640

45 min
Extra loss
63 min
264
329)2640(8
2303
337

329)2640(80%
263
80

95 Extra loss 15% Bury
264
359)2640(72%
2513
1270

April 6 1887

Machine off mean 1017 time 9.10
Extreme 1039
another extreme 996 = mean = 1017
main shaft 18 one minute
1017
999
18 one of the to time
machine
1037 lbs
Engine at rest
at rest
1037
9.54
5 5 one and the time
counter shaft machine and
magneto on

Shaft 2¼ inches

15 inch pulley

30 inch

10 inches

1½ machine

2½ inches

325 / 3

70.68 / 12

Shaft 6.72 feet

1.5 4.77

471) 2000 / 1884 / 1160 / 92

42

150
.05
7.50 lbs friction

1100

12 | 1.5
1.125
31.5
506
125
375
.3925 ft
1100
3925
3925
4317.500
8
34.48 ft lbs
17000

125 lbs
150 lbs Wt armature
Min. R

12 | 1.5
.125 feet
.125
1130
3750
125
141.200 feet per minute
18.25
766.6
2.8322
5672
5.3.3.6
3
2649 ft lbs

125
.05
6.25

99 ~~5~~ machine on running magnets. ~~and~~ brushes off

95 machine running bind

Calorimeter

The floor is much colder than the rest of the room

The calorimeter may be slightly moist should be perfectly dry

For example

Temp floor 59°F

Top calor 64°F

6 ft Higer in room 66°F

7 feet 67°8F

Water in calor 89.9°F

171
735
835
1197
1197
1323 05
.029
1190 745
2646 10
383 615 65

1°25

16) 1.25 (.078
112
130

0°.0787 per minute

831
81.3
.07) 1.80 (.029
124
560
558
2

0°.0297 per minute between 82°.1 and 81°.3

.029

38.36 ft lbs per minute

1½ hp

Time	
11-2 30	89°9 Water in calor floor wet calor wet
11-6	89°5 F Woodsalon
11-15	Bottom air 59°5 F Top calor 61°47 air room 6 feet 66°7
11 22	88°25 F Stopped stirring
11 46	86°4 F
1-15	83°1 F
2-17	81°3 F
4-23	77°2 F
8-20	71° F

18)300 (.166 Ohm
18
120
108
120

.166

1900

1000000 .166
9
1.394

1.4 Ohms

Resistance outside box
outer stirrer $\frac{70}{5} = 14$ Ohms

$\frac{9000}{5} = 18$

resistance outside 1.67 Ohms
stirrer
Inside 1.8 Ohms
Strong current

660) 3300 (5
3300

Running machine
with hand power

Mr. K turned

360
3
1080 revolutions

per minute with the
crank of and was cur-
rent on magnets

4 cells Condit & Hanson
3 cells of Fuller
magnet

14 Volts

.8
2.1
1.5
4.4

4.4) 8682 (1970
44
428
396
320
308
12

660 for the
one magnet

12.2) 81,356.0 (6660
732
815
732
830

16 000
9
9 [illegible] = 16 [illegible] 1146 (4
60

900) 75 (12.2 Ohms
75
75) 900 (12.2
75
155
15

$\frac{1}{50}$ H.P. on magnet

Van Cleve with 27 Ohms external turned 53 Volts
4444 ft. lbs.

Van Cleve and Dr. Haight turned 8300 ft. lbs.

Edison	140	15 Ohms
Francis	135	[illegible]
Dohm	130	2nd time 125
Clarke	115-120	
Lin	120	
Holze	125	
Van Cleve	135-140	
Upton	[illegible]	

Matt 120
Hammer 110-112
Billy B 110-112
Force 135
Francis 135-140
Hammer 125

O 2 to L

Lawson 120-122

140 [illegible]
[illegible]

84

.06480	.0648	.0648
24	.65	
2240	2240	.3888
.296	6480	
16200	9720	

No 2 615.389 grains + 0 grains 615.389

No 1 588 grain 1.5 grains 588.972

after 26 minutes

11	639	20 grains	640.296
1	564	2.5	564.16

640.296	588.972
615.389	564.16
24.907	24.812
24.812	
49.719	

26) 24.859 (1

24.859	4.3955
simple 26	8.5851
simple 19.5	8.7100
	1.6906
49 Webers	1.6906
	1.6464
1.7	0.2705
154 [illegible]	0.2581

51.276

April 8.

7

I [illegible]

1000 N.C.

8600 Ohms other

$\frac{300}{18}$ = 16.6 Ohms

Boxes [illegible]

.25
.085
1.825
86
1092
1256
1.56 [illegible]

Measure [illegible]

1.60
.0675
1.53 [illegible]

$E = \frac{g}{R} CR$

$R = \frac{i}{g} \frac{c}{o}$

Cu. I.E.M.F.

$R = \frac{i}{c}$

81 .14

192.000 47

.0261

Total 204.500 5.3108

April 8

Connecting wire .07 Ohm

Time	
2-40	6 boxes .5 Ohm
	Temp 67°.2 F
	6 in tower .49 Ohm
	.49 Ohm
	Tower 1.52 Ohms
	1.52 Ohms
	.5 Ohm
	74° F

207000 ft. lbs. [illegible]
192000 [illegible]
247000 given in the manuscript

775	2.8893	85.5
171	2.2330	55.7
29.8	1.4742	29.8
Comp 25	8.6021	

5.1986
.1184
.0261
5.3431

15.8000
Calor
220,000

243	2.3856	5.1986
185	2.2672	.1184
1.313	.1184	5.3170
17	.2304	
	.3488	
2.23		
.14	.3749	
2.37	.3488	
	.0261	

April 8

3-10	6 boxes .52 Pine [illegible] .51 [illegible] .51 Placed on shelf 71° F Thermometer [illegible] 1.7 Ohm ~~[illegible]~~ [illegible] 100 Ohms [illegible] [illegible]

April 8

5-15	Resistance 2 Rubber thoroughly dry 1.71 Ohms
	in water 55°27 163 Ohms
	[illegible]
	20 cells [illegible]
	Magnet 1.38
5.42	Smooth. 98°.
5.43	Temp. of air, 69°.
5.45	Temp. of water 55°.
	20 cells = 51. Deduction,
	circuit open. 27.

94

93.152
173
93
51
153
1.581 Ohms

15
.93
64
135
1.724 Ohm
in Galvon

as 5.0276
.1987
5.2263

168 0000 ft lbs
130
87
Copper.

5.3420
.1987
5.1433

139000 ft lbs
Galvon

150.450 ft lbs
Calorimeter mean of
168
139
307
153.000 ft lbs

92°.3. C.

April 8

5.50.	Plugged generator.
5.53.	9300. Ohms.
5.55.	Temp. of water 61.1°C.
	Dynamometer. 747, 733. MEAN
	" 739, 734. REG.
5.57.	Electro-dynamometer 57°.
"	Temp. of water 65.8 = 65°7.
6.00.	Dynamometer. 736. Regular.
	26. cells = 50.
	Deflection
6.05.	Dynamometer 733.
6.07.	Temp. of water 74°.5.
6.09.	" " " 76°.5.
6.11	" " " 80°.2.
6.15	" " " 85°.5.
6.16	Plug pulled out of generator.

E.M.F.

2.5.5
1.08
2.040
2.75
2.7540

2.75) 185.00

~~185 / 2.75 = 71~~

244 2

$\left(\frac{185}{2.75}\right) \frac{44.3}{1.7}$ = Volts 0.4393 1.7463

6

6

0.5720

Volts

2.2671
9.5807
9.7695
1.6173 40.9 Webers

244 2.3874
comp 2.75 9.5607
1.9481 88.7 Volts

April 8

973 Dynamometer

20 cells 210-209

83 around resistance boxes

Plate 11

639 grms 20 grains

Plate 1

564 2.5 grains

20 cells 50 & 51

around cabor 185

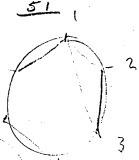
Total machine 243-245

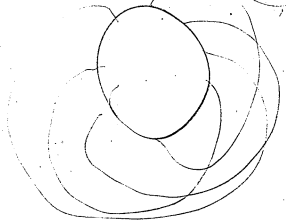
98

28) 210
1.05
1.08
8.93
7.5
1.13 40

#13) 8.3. (7.3 Volts
7 9 1
3 9 0

17) 7.3 (4 3
6 8
5 0
5 1
43 Volts



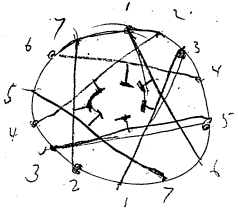


99

4 4.3
9
7
4 1 8.7
20
8 3 7 4.0
2
1 6 7 4 8
2
3 2

1/10

14
28



4

.00373) 44,300 (11,800
373
700
373
3270

44.3

44300

11.800 ft. lbs

2

23600 ft. lbs of one coil with Volt 2.111.7 in short circuited

Tried to see if position of brushes made much difference could not detect the change in power [illegible] with magnets dis for [illegible]

Conductors for Park

	Length	Lamps
(1) One line equally distributed	2150	28
(2)	1500	20
(3) End of 1200 feet along 300		4
(4) Distance out 420 feet along 1700 feet		19 lamp
(5) Distance out 700 feet along 300 feet		4 lamps
(6) 300 out along 2000 feet		23 lamps
(7) 1300 out along 300 feet		4 lamps

(8) 700 feet out
along 1300 feet 15 lamp

(9) 1500 feet out
along 300 feet 4 lamps

(10) 1500 feet out
along 300 feet 4 lamps

(11) 700 feet out
along 2000 feet 6 lamps

(12) 700 feet out
along 2500 feet
~~[illegible]~~ 3 lamp

(13) 1200 feet out
along 600 feet 8 lamps

(14) 2700 feet 26 lamps

(15) 2200 feet 28 lamps

Time	Remarks
P.M. 1-30	Passed about 45 Volts through 18 Ohms as three Ohms each in multiple arc. One bar measured. Cold 3.09 — hot 3.20

3.) .11 (.036 %

3.6 % difference hot and cold

Resistance of bars see page 91 .173 Ohms

.036
.038
.1
.00228
.173
.18 Ohm

989
873
116 ave

165
775
940
1176
1176
1 2 3 2 . 3 6
2510 00
7836
8091 60 0
1.42
16182
32364
8091
11 4 8 9 2 2

8213
6302
30.5) 1911 .62
1830
81

250
176) 250 (1.42
176
740
704
360

Dynamometer 116 ave

Watts

168	2.2253	Imp/176	4.9113
775	2.8893		7.7005
19.1	1.2810	Inst hoz	2.8779
			2.8779
Comp. 30.5	8.5157		0.0286
	4911 3		0.0279
81.900	0.1573		5.0340 total
	50636		116 ave

1020
959
1979
989 mean

P.M. Dynamometer.

3.15. Temp. of water 63.2.
3.15. Temp. of air 72°
3.05. Plugged generator
3.06. Electro dynamo 1.9° 28'
3.08. Dynamometer 915 revs.
3.09 Electro " 11.° 41'
3.11 Dynamometer 845 revs.
3.12 Temper of water 67°.7

1979
940
39
177

23.250
83.3

59 1.7708
1.72 0.23555
.5353

34.3 Webers

Apl 9. 1875.

3.14. Electro dynamometer 14°35'
3.21. " " 15°
3.22. Edison " 910. lbs
Th. 70 cells = 65
First det 250 – 250 total
on cabor
Second " 176 – 177 910
830. lbs.
3.24. Edison dynamometer
3.26. Tem b? of water 75°.5 875
3.27. 95 ... Chum
3.28. Electro dynamometer 15°

The copper cells between the plates 100° F turning 80° = made a large difference in the signal after turning to right

over

2x 1207

comp 10.35 8.9855
comp 1.08 9.7664
60 1.7787
.7302
comp .18 10.7447
1.4749

29.8 Webers from resistance boxes

.7302
comp .17 10.7696
1.4998

31.6 Webers

Apl 9. 1885.

No. 1. [illegible] around resistance boxes 60
No. 2. around electro-dynamometer
No. 3. around copper coil 134
[illegible] 82.3

3.36
3.35.2

[illegible] of [illegible]

20 cells equals 207
60 on resistance
134 on [illegible] cell
Magnets 5 Volts

.06648
15.5
584 grms

$\bar{2}.8116$
1.1903
.0019 = 1

.06648
115
618.745

$\bar{2}.8116$
1.0607
$\bar{1}.8723$

640.296
618.745
21.551
19.84
1.711
.855

584
564.16
19.84

584
618.745
1202.745

640.296
564.16
1204.456
1202.745
1.711 loss

21.551
.855
20.696 Grammes

No. 1 Plate 583 grms. 15.5 grains
No. 2 Plate 618 grms. 11.5 grains

Wt of H_2O 159 lb
17 with cord
~~7~~
~~98~~ lbs

20,700 4.3159
comp 30.5 8.5157
comp 19.5 8.7100
34.8 Wchp 7.5416
83.3 1.9206
1.6464
5.1086

128,000 ft. lbs.
5.1086
136000

Results

The strength of the current varied. ~~[illegible]~~ ~~[illegible]~~ during this or owing to the heating of the sulphate of copper solution

Deflection 116000 Lt. Ms. Dynamometer
125000 Ft. Ms. Calor

This is due to the fact that the dynamometer test was not made until after the current had decreased

136000 by Current

Calling resistance Calor 1.72 Ohms
34.3 Webers

Calling resistance Dynamo .17 Ohms
31.6 Webers

From Cu. deposition
34.8 Webers

992
857.5
134.5

820
895
115
857.5

134.5 ft lbs dynamometer

541 30
5 27 30
14

77
67.6
94 3 (267
89

171 2.2330
775 2.8893
9.4 0.9731
comp 14 8.8539
87.000 4.9493
233 2.3674
comp. 190 7.7213
109.000 5.0380 outside
for specific 1.02 .0086
5.0466 111.000
1.72 0.2355
232 2.3676
comp 192 7.7213
.3242 5.0277
.14 7.1421 5.0743
6.53 7.8219 5.1287
.9456 88%
commercial

Experiment 2
Apl. 9, 190

200 lbs H_2O Sample

20 = 65
Pressure 14

First obs 26 (-267

5.22. Edison dyns. 1025. lbs.
P.M. " " 960.
1985
992
5.23. Plugged generator
5.24 Electric dyns. 19.
5.26. Edison " 820. lbs.
5.27-30 67.67 H_2O
5.31. Edison dyns. 895.
820
5.32 " "
5.32½ Electric " 19.5

~~26~~

34.2 1.5343
+4.3 .6464
59 1.7094
5.1301

135.000

Resistance

Comp 10.35 8.9852
Comp 1.08 9.9666
65. 1.18129
comp .17 10.7696
1.5343.

34.2 Webers 10.7696
.7647
5.81 Volts 1.5773
2.3420
1.6464
3.9884
1.9823
93 4.9707 93.600

41
23
18.5

Ex. 2. April 9

5.32.2 Temp. of water 71.°
5.35.30 18° 40' Elec Dyne
5.36.30 Temp. of water 73.' 2'.

Current on ~~Dd~~ 233-234
77.6 Volts

Dd 189 - 190 around cabin
5.39.30 Temp. of water. 75.°4.
5.41.30 Pulled plug
" Temp. of water 77.°
29 cells = 207
Dynamo resistance 1.5
Speed 156 revs shaft

Comp 1.16 .0648
1.4

570.091

632.097
1202.188
1202.745
.557
.278

584
570.091
13.909
.278
13.631
comp 18.5
comp 19.5
37.8 Webers
77.6

$\bar{2}.8116$
.1461
$\bar{2}.9577$

$\bar{2}.8116$
.1761
$\bar{2}.9877$

632.097
618.745
13.352

4.1344
8.7329
8.7106
1.5773
1.8899
1.6434
5.1036
.0277
5.1312

8)232
77.6

100000

Plate 1 576 grams 1.4 grams
Plate 2 632 grams 1.5 grams

63 1.7993
63 1.7993
4.43 1.6464
comp 1.72 9.7645
5.00 34

1.7993
9.7645
1.5638
36.7 Webers

Flux
1.77 Webers
1.7993
.2450
1.5513

35.6 Webers

Resistance stirrer 1.77 Ohms

	1.77	0.2480
	37.5	1.5775
	37.5	1.5775
	44.31	1.6464
Total		.0887 outside
Machines		.1477
		5.1655

Total

Results

134.500 ft. lbs. dynamometer

118.000 " " brain torque

135.000 ft. lbs. calculated from current and E.M.F.

Calculating from E.M.F. [illegible]

35.6 Webers

Calculating [illegible]

[illegible] Webers

Calculating from resistance

[illegible] Webers

128

289. 2.4609
Chips 171 7.7620
.2279
1.12 .6492
9.7220
66.2 .8212

The resistance of the small should be from quantity of H_2O
66.2 / 100 Ohms

Small 127 7.8962
~~1~~ 71 1.8513
1.12 0.0492
.627. .9977

from the galvanometer it seems to be .627 Ohms

289 : 171 :: 1.12
171
112
784

19.152 | 7.66
.434
1812

.93
.66
.27
252
140

.032 | 8.4

April 12 1888 129

~~Large small~~ stiner
1.17 − .05 = 1.12 Ohms
at 68° F

Search for small adjustment
.58 Ohms − .05 = .58

23.

27 turns on small stiner

192 lbs of H_2O Tr resist
H_2O
189.75
27) 1.88 (.08 2 Ohm per turn
81
70

192
110
56
358

110 lbs
23.75
86.75
56
23.25
32.75

169.75
86.75
32.75
289.25

~~0.648~~

.0648 $\bar{2}.8116$

2.5 0.3979

$\bar{1}.2095$ .162

4.5 .6532

$\bar{1}.4648$ .291

14 1.1461

$\bar{1}.9577$ .907

565.162
626.907
1192069

599.291 No 2
592.291 No. 1
1191.582

592.291
565.162
27.129

626.907
599.291
27.616
.243
27373

1192.069
1191.582
.487
243

April 12 1880

Strong .65 Ohm

No 1 565 grms 2.5 grams
No. 2 626 grms 14 grams
No. 2 599 4.5 grams
No. 1 592 4.5

30 | 27.373.

912.4
19.5

46.7
109 Volts

2.9597
1.2900
1.[illegible]7
2.03 65
1.6[illegible]
5.3526
1.9934
5.3260

985%

221.000

outside
galvanometer

Chemically pure water

Through the tubes body four cells = Def 350

3 cell .. 282

2 200

1 110

7000 ohm 1 cell = Def 90

2 160

3 230

4 285

4 cells C.P against 4 cells of Standard 35 L

Direct

4 cells C.P against 4 cells standard 15 L Shunt on

3 cells C.P against 4 standard

300 R

4 cells C. P against
4 cells Standard 4-5 L

4		0.6021
2.85		2.4528
		.1493
1.4%		
1.5%	1015	.0065
		.0065
	1.03%	.0130

3% increase of work due to polarization of battery or playing out

9118

171	2.2330	289	2.4609
775	2.8893	775	2.8893
.437	7.6405	.45	7.6532
	4.7628		5.0034

57.900

101000
57900
1589.00

2.45
2.18
27

~~2.45~~
~~2.19~~
~~26~~

72.1
60°3
11.8

70.2
61.2
.90

2.39
2.19
20

11.8
27
Small
.437

1.0719
1.4314
1.6405

Large
.45

Office

June	Edison Sys. [illegible] 10.30 [illegible] 9.00 [illegible]
1.4.10	[illegible] 5 volts on the magnet

45 = 15 Volts on magnet
20 cells = 50 for rest
284 − 252 / 3 = 97 Volts

Apl 22 Edison Sys. 9.26 10.22 [illegible]
280 − 279

2-15 Started 3
2-15-20 34° 24'

~~Sy [illegible]~~

2-18 60°37 Small
2-14 61°27 Large

71
127
198

25.2
Comp 198
158.900

2.4015
7.7043
5.2011

.1056

5.8067

203 000 Calor Total nutricle

Dynamometer

980
725
Edison 255 000

955
745
240 000 Sylvan

2.5

7-20 800 lbs Lyne
700 lbs. Lyne N
790
700 lbs Lyne

2-27 30° 3½'

65°.2 F? Small

2-29 250 - 252 - 254 - 252
from machine

2-31 66°7

71.2
71.4
71.8
71.6
71.7

Air 68°.5 F

71
127
198

1.12
.65
1.77 Ohms

198 2.2967
Comp 2.5 9.6021
1.079 0.10330
~~Comp 1.77~~ 1.9318 250
1 44.3 1.9318
Comp 1.77 1.6468
9.7520
5.2620
1.9868
5.2488

9.6351
2.4015
2.0365
109 Volts

175000 ft. lbs galva in calor
.1056
5.3544

226000 ft lbs outside by galvanometer
1% subtract for conducting wires
224000

2-36 71 on Small calor
2-37 68°.57 Small calor
2-39 70°.27 Large calor

725
729 Edison
732

2-40 127 on large calor
2-45 Stopped
72°.1 Small calor
975
980 on
7 Large Calor measured but not noted.

1.21
65
1.86
1.88 .2742
.1056
.3798
2.39 Ohms .14 0.1461
7.7663

584%
1.058 5.0245
221.000 5.3444
5.3689

233.000

224 5.3502
.0245
237 5.3747

203 5.3075
.0245
5.3320

3689
4065
7754

3689
3802
7487

3747
4065
7812

3747
3802
7549
342 4
406 8
9359
342 4
3802
9622

Large calor
Stirrer ~~25~~ 7.25 lbs
Vessel 26.5
33.75
Calling all inn 37.08
3.7 lbs of Ice

Result

Dynamomometer

Outside	Edison	255.000	ft. lbs
	Upton	240.000	
	Galva Cu. cell	221.000	
	Galva Resistance	224.000	
	Calorimeter	203.000	

Total Galva Cu cell 233.000 ~~90~~
Galva Resistance 237.000
Calorimeter 215.000
Add 2% for vessel stirrer 220.000

	Edison	Upton
Galva Cu cell	91.7 %	97.4 %
" Resistance	93 %	98.7 %
Calorimeter	89.3 %	91.7 %

1915

Experiment 2. 147.

Time	
	Magnets
	Armature
	Wt. H_2O vessel in small calor. 179.5
	" " " large ~309.5
	Temp. small calor
	" large "
	Started

22
22
24 lbs of H_2O to be added to small calor.

3.7 lbs of H_2O to be added to to large calor.

311
3.7
314.7 in large calor.

180
22
158
2.4
160.4 lbs heat capacity small calor.

In large calor.

179 ~~lbs~~ net 23 lbs small in vessel

122.5 gross
23
99.5
179
278.5 lbs
32.5
311 lbs in large

Temp 61°.87

~~164.5~~ small calor

180 lbs gross

at 62°.77

675
760
1435
717 mean

946.5
1020
1966.5
983.25

6-4	65 Volts on magnet
	946.5 Extremes
	1020
6-9	Started
	37° 45'
6-15	
	20 cells = 50
	Circuit now 296-295
	closed 261-260
6-12	Elec Degree 34° 30'
6-13	74-73.5 around small color
6-13	675 just touching other metal
6-16	760 717 mean

788.5
635
1423.5
711.7
712
1428.7

Means 714.35
983.25
2 | 2689
134.415

314.7 2.4978
comp 160.4 7.7949 lbs in calories.
73.75 1.8672
143 2.1599
in place of 130 from resistance Galva

---

63 : 114 :: 73.7 1.8675
Resistance times 1.14 2.0569
comp 63 8.2001
.133 2.1256
in place of 130 from resistance.

---

comp 73.7 8.1325
2.1139
7.7993
2.0457
1.11 Ohms from deflection in
place 1.14 from resistance

6-17 130 - 30 large
placed the weights so that the arm just left vertically the rule behind it was held.
788.5 711.7 mean
635

6-20 258 Total

6-22 696 Large calor.

Air 703

very probably the shutter slipped

6-24 Speed shaft 175
Pressure 2.5 lbs Engine
2.3 on Brake.

6-27 Speed 33° 47'

6-30 256 Total

[illegible] 184.000 268.900 ft lbs

20.000	3.3010	
comp 184	7.7352	
176	2.2455	
191.3	3.2817	
134.45	2.1287	
257.000 ft lbs.	5.4164	Syne

79.3	78.4		6 40
62.7	61.8		6 9
16.6	16.6	1.2201	31 minutes
	31	1.6314	
		1.7287	73.75
			130
			20375
			259

Large	314.7		average calor total	5.5660
small	160.4		16.2	1.2095
	475.1	2.6767	comp 31	8.5084
	775	2.8893		5.2841
		7.7287		
197.000		5.2947	192.000	7.6911
comp 203.75		7.6911		2.4133
259		2.4133		5.3885
250.000		5.3991	244.000	.0248
Page 142		.0248	259.000	5.4137
Cajon 265.000 ft lbs		5.4239		

(3.55 [illegible] in 2 minutes
177.5

Carbon
34° 32' Blas Syne

[illegible] Total [illegible]

[illegible] 32° 40' [illegible]

[illegible]

[illegible] Sample [illegible] 78.9
Large 78

Acid .4 for the 15 minutes
small calor 79°.37
large 78°.47

117 Page 130 .0648

6.620.804

571.324

1192.128

620.804
592.291
28.513
965
478

28.729

comp 31
comp 19.5

47.9 Webers

Page 140 constant 259

111 Volts

2.8116
1.0934
1.9056

2.8116
.6990
1.5106

599.291
571.324
28.965

4.4624
8.5086
8.7099
1.6809

9.6351
2.4133
2.0484
1.6809
1.6464
5.3751
.0248
5.4005

Actuals 237000 ft lbs.
Curve mit
Actuals 252,000 ft lbs
battery corrected

117

Wt no 1 620 gms 12.4 grains
571 gms 5 grains

9.30

0.7
6.47

Small 78.9 76.7 2.2 comp 15.5 15

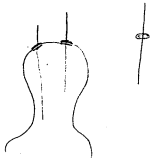
Large 78 76.4 2.6 15.3 26

9.30
6.55
235
124
1.55

.218

3.4124
7.8097
1.1761
9.3282

0.4850
7.8277
1.1761
9.4008



314
2.9 capacity vessel
.25 water in vessel
.7 capacity stirrer
.6 water in stirrer
3184.5 lbs of H_2O

2275
2175
25.025
265
265
281.5

April 13 1850

Put 314 lbs. in large
160 " " small

152 Gree
23
129
103.25
81.75
314 lbs of H_2O
in large calor

105
23.25
81.75

Small calor

152 gree
22.75
159.25 Nit
.5 Stirrer water
2.5 capacity
.5 Stirrer capacity
.25 water in vessel
3.75
163.00

.0648
4.5
3240
2592
620 .2916 No. 1.
568 324
1188.6156

.0648
.3240

Plate 1 620 grms 4.5 grains
Plate 2 568 grms 5 grains

Resistance 1.21 Ohm
Large stirrer 1.14 Ohm in H_2O at
2.54 Temp 61°.5 F

Small stirrer nearly dry
weighed 7.25 lbs.
The vessel was taken as
weighing 6.6 lbs.
Page 147 Large stirrer
weighs 7.2 lbs
Vessel 46 F

Resistance small stirrer
.70 - .07 = .63 Ohms
in H_2O

265 - 264

264.5
15
13225
26415
.15 3967.5
3906
3785
60) 15853.5
260.9 average outside

20 (52.25
comp 2.612 9.5931
1.079 0.0020
260.9 2.4164 9.5961
2.8225
103 Volts

260
15
1300
260
3900

259.5
30
7785.0

20 cell = 65 - 64

Made magnet on machine = 45°.

20 cell = 52.5 - 52

Dif on machine 301 - 300

3-27	Temp small calor 62° F.
	Large calor 62° F.
3-32	Calor dimin. 1/5.
3-35	61.9° F Large calor ~~[illegible]~~ through.
~~[illegible]~~ 3-36	62° F

16 4 985

705 lbs
5
3525
3525
3525
3550
3580
2175
22980
60 | 42860
714 lbs

985
714
271,000 ft. lbs.

716
5
3580

725
3
2175

710
5
3550

715
32
1530
7145
22880

16 4

3-39	Started
3-40	35° 53' Elec Dyne
	705 lbs on dyne Elec
	840 650 1490 745 change Dyne
3-45	31° Elec Dyne
3-47	182 185 185 Howell shed shaft
3-48	716 Dyne
3-50	32° 30' Elec
3-50	705 dyne

comp 76 8.1192
131.5 2.1188
.63 7.7993
1.09 0.0373

1.09 ohms in phase 1.14 ohms measured

131.5 2.1190
9.5961
1.7151
1.7151
1.6464
comp 1.14 0.9430
5.0197

104.500

Total 265-264 Galvo
Large calor 131-132 Galvo

3-52 Air 76° F 76 + 14 = 90°F
62
14

4— Small cal or on galvo.
77-75

4— 710 lbs dyne
183
183

Tr. 8 725 lbs dyne

4-9 260 - 260
40 715 lbs dyne
184 speed shaft

133
comp 77.5

133
77.5
comp 210.5 7.6768
259.5 2.4141
.0909

90 90.8
61.9 62
6 | 28.1 60 | 28.8
.4.68 .48 per minute

Large small

318.5 2.5031 × 163. 2.2122
77.5 2.8893 77.5 2.8893
.468 7.6702 .48 7.6812
5.0626 4.7827

115.500
60.620
176.120

60.620

5.2458
.0909
5.3367

Color
217,000 Hills

4-18 Large color 133-133

4-19 81°7 Large

4-21 92°57 Small color
Small 77.5 76

4-27 Total outside
260-259

4-29 85°67 Large color

4-32 88°77 Small "
260-259

4-39 Stopped

Large 90°7
Small 90°8
296-295 " Col. 4

.0648
674.0648
512.3392
1186.9040

2.8116
1188.616
1186.904
2.212
.106

0649
5392

674.065
620.29
53.775
1.106
60 | 54.881
91.47

568324
512.379
55.985

2.9613
8.7100
2.0125
1.6460
5.3302

seconds 19.5
Volts 103

No allowance for batteries
214 ows ft lbs

No. 1 674 grains 1 grains
No. 2 512 grains, 1 grains

Large stirrer	8 lbs	wet
small —	7 1/2 —	—
Large calor	26 1/2 —	—
small —	.23 —	—
Large stirrer	7 1/2 —	nearly dry
small —	7 —	—
Large calor	26 1/2 —	dry
small —	23 3/4	
Large stirrer	6 lbs 15.5 oz	thoroughly dry
small —	6 " 6 oz	" "
Large vessel	26 lbs. 6 ozs	
small —	22 lbs. 13 ozs	

22 13
6 6
29 days

Chem pure cell with siphon
142 on Elec

Standard 137 on Elec

~~Dynamo and Demand~~

Magnets of such strength as to give $\frac{280}{3}$ volts from armature thin plate iron machine running 1700 revs.

~~Flat wire~~ ~~Thick plate~~ machine running countershaft

3 motor

field left on countershaft make 148 revs before stopping after armature opened

field off armature opened 243 revs

field on brushes off 161 revs.

Thin plate running
·037 plates

Field off armature on brushes on
336

Field on brushes off
295

Field on brushes on
277
again 269

New machine
Field on very weak
from reversing
D = 0.845

182

after bringing up 153

476 field on

465

Field and immature

off 759

19° 45'	2 | 7.5288		
	4.7644	.581	
		2	
		1.162	2
15° 50	9.50896		1.5
	4.75447	.568	2
		1.5	
		2840	3
		568	2
		.8520	1.5
15° 30	9.44390		
	4.71945	.517	2
		2	
		1.034	14
14° 30	9.39860		
	4.69930	.500	
		3	
		1.500	
15° 10	9.47768		
	4.70884	.511	
		2	
		1.022	
15° 40	9.48142		
	4.71571	.520	
		1.5	
		2600	
16° 20	9.44225		
	4.72462	.530	
		2	
		1.060	

145
13
435
145
2900
1435
1450
35
25
1.5

143
1.5
715

Note 3 Plate 1 588

549 grains 2.5 grains

Plate 4 548 grains 1.5 grains

Plate 3 548 grains 1.5 grains

— 4 548 — 12 grains

Fairweather

135

11.29 Flat

140

11.30 19° 45 Sun [illegible]

138

11.32 18° 53'

1.2

1.5 -33 15° 33

2. -22 14° 22

3. 11.39 13° 13'

2 11.40 12° 43'

1.5 11.41 12° 43'

1.5

1.5

Alternate instant

16	9.45758 / 4.72879	.548 × 2 = 1.096
16.55	9.46356 / 4.72178	1.096 × .539 = 1.078
17	9.46594 / 4.72297	.548 × 2 = 1.080
17.10	9.47105 / 4.73502	.548 × 3 = 1.629

1.102
.852
1.034
1.500
1.022
2.600
1.060
1.095
1.096
1.078
1.080
1.629

log .608 4.78389
7.56550
36.6 3.21839

25 | 15.209 | .608
150
20 9

11-44	15° 40'	2
11-46	16° 41'	2
11-48	16° 55'	2
11-50	[illegible]	2
11-52	17° 10'	2
11-54	[illegible]	3

No. 4 Cu 563 grams 14 grains
No 3 530 grams 7 grains

.0648 × 14 = 2592 + 648 = .9072

.0648 × 7 = .4536

No 3 530.453
No 4 563.907
1094360

·0648

Plate 3 — 4'

	548.0972
	546.777
	1094.874
	1094.360
	.514
·0648	·0648
1.5	·12
3240	·1296
648	·648
09720	·7776

1/2 = .257 loss

31140 / 46.6 / 1/2 ft

old 548.097
new 530.453
loss 17.644
.257
17.901 — 4.2529
comp 25 — 8.6021
comp 19.5 — 8.7100
1.5650
36.7

497 · 6
5.4
11.4

two 497 — 2.6964
lbs 11.4 — 1.0569
feet 6 — 0.9031
4.6564

45,000 ft. lbs. outside

200 on H.P
66.6 Volts on motor

Dyn 11° 35' — 9.3027
4.6513
3.2189
27 Webers — 1.4324
66.6 — 1.8235
1.6464
4.9023

79,800 ft lbs given machine
4.6564
4.9023
·7541

56% in outside work

190 25°	9.6259 / 4.8129	.650
22° 25'	9.5813 / 4.7906	.617
18°	9.3521 / 4.6760	.474
~~14.4°~~	~~9.4049 / 4.7024~~	
18° 40	9.5052 / 4.7526	.566
20° 18	9.5402 / 4.7701	.589
21°	9.5543 / 4.7771	.598
21° 10'	9.5576 / 4.7788	.601
19° 45	9.5288 / 4.7644	.581
20° 25	9.5426 / 4.7713	.590
	9 / 5.2266	.585

4.76716
1.5831
3.18406

Test Motor No. 2 191

	Constant Dyne	
3-13	Started	139
3-14	25° E.D	140
3-16	22° 25'	145
3-17	43°	
3-18	14° 42'	150 145
3-20	18° 40	143 141
3-22	20° 18'	129
3-24	21°	140
3-26	21° 10'	Moved in [illegible]
3-28	19° 45'	143
3-30	20° 25'	
3-31	Stopped	
3-13		
18		

192

·0648
4.5
3240
2592
·29160

·0648
13.2
1296
1944
648
·85536

321)480 (1.4
321
·590

424
116
2544
424
49296

544.291
530.453
13.838
562.907
540.855
13.042
13.838
26880
13.440 Gmms

544.292
540.855

13.440 / 3.1283
comp 18 8.7448
comp 19.5 8.7100
1.5831

36.3 Webers

193

Plate 3 544. gms 4.5 grains
Plate 4 540 gms 13.2 grains
Elec. Dyne. ·09 Ohms

321 Countershaft 1 min
480
642
960

113 revs 1 min
4
452 revs
14.75
109
4
424
15.5

15
70
14

5.8
14
.294

424
8
3392

3392
20.9
30528
6784
708928

15.5
5.4
209

80
5.5
440.00

443
6400
177200
2658
3 | 2835200
945000.#

220 HP.
544
6 1/4
10° 10' Elec Sigma
10° 30'
285 1/2 rounds
220
6 lbs 6 lbs
10° 35'
559 revs

Magnet alone 10½ Volts.
Battery same direction 15½ Volts
Opposite — 1½ Volt
1 cell of Daniells internal resistance 2.5 Ohms Con—
Battery
Battery taken off 1½ Volt
Cell carbon filler and Daniells 25 Volts R

202

Photometric test [illegible] 17. 1880.

81. Ohm in resistance [illegible]

Rivadavia [illegible] [illegible]

385. on high resistance

170. on [illegible] 50 ohms and lam

7. candles [illegible]

8½. candles 10% off the [illegible]

17. candles [illegible]

178 on low resistance lamp

175 on 4 ohm

290 on 4. Ω

204 [illegible]

[illegible] 119. [illegible]

[illegible]

[illegible] edge

[illegible]

[illegible] Camp

[illegible]

[illegible]

[illegible]

Apl 17. Fr. 205

20 Photometer test Apl 17. 15.

Board #129 cold. 119. Dim.
On the lamp 165
21. candles broadside.
8½. " on edge
On lamp 170.
165 on [illegible]
15½. candles broadside.
12.2. "
273 on high resistance
175 on lamp
21. candles broadside.
270. on high resistance
170. on low resistance
P.M. 4.06 21. candles broadside
4.07 21.2 " "
4.09. 23.2 candles broadside
One or two bad spots in carbon.

Apl 17. 80. 20.

Safety catches

4 wires of lead-tin
bindle [illegible] .654 m each

33° [illegible] line

Page 190 constant
dyne 3.18406

2(9.7361
4.8680
3.1406
1.6874

48.7 Webers

3) 250
83.3 Volts

3) 260
86.6

Apr 19

Lamps in Series

	Amp	RR	E.M.F.	Candle Power
Opaque	144	250	135	7½
Clear	122	252	131	7½ Nearly Out
Opaque	157	250	125	9½
"	153	252	120	9½
Clear	170	250	110	8½
Opaque	163	256	110	8
Clear	140	255	128	3½
Clear	167	257	104	3
Opaque	173	260	95	9½
Clear	187	260	90	8¾
Clear	138	255	180	2½
Opaque	152	255	107	7
Clear	122	250	170	6¾
Clear	142	255	112	8

210 12.5
3 9 7 6
1 1 7
5 2 5 0

	1 cm	2
	1.088	0.03663
	1.106	0.04376
		1.99287
	1.171	.0686
comp.	1.190	9.9245
		1.98597
	1.308	.1166
comp.	1.327	9.8771
	954	1.9797
	1.485	0.1717
comp	1.505	9.82246
		1.97386
	1.722	0.23603
comp	1.749	9.75845
		1.96834
	2.056	0.31302
comp	2.081	9.68173
		1.96309
	2.548	0.40620
comp	2.577	9.58889
		1.95818
	3.38	0.52802
comp	3.419	9.46636
		1.95256

Color	Arms	High	R	G-R	2/11 radius
Plain	125	255	—	—	8¼
Plain	146	252	112	11	
Plain	133	250	118	4¾	
Plain	158	252	100	11½	
Plain	128	250	125	8½	
Plain	129	252	125	7½	
Opaque	146	250	115	13½	
Plain	102	252	102	9¾	
Plain	140	250	125	15	
Plain	147	252	115	15	
Opaque	205	255	75	2	
Plain	150	255	115	15	
Plain	145	255	120	17½	
Plain	123	255	130	9½	
Plain	142	250	140	3	
Plain	139	255	133	8	
Opaque	150	255	123	10½	
"	150	255	125	11½	
Plain	177	255	108	9¾	

	Ohm	M.R	L.R.		Candles
Plain	131	255 -	150	(Dip)	25
Plain	119	250 -	160		11¼
"	129	253	135		6
Plain	119	253	150		5
"	153	250	115		6½
"	145	248	(?		10

5.5
9.5) 5.5 (58 %
475
750

17) 9.5 (55 %
85
100

Face frosted globe
Edge 9 1/2 candles
5 1/2

Face
17 candles
Edge 9 1/2

Edge 56 % of Face

Page 207. Safety checks

.042 wire 28° Elec
degree .red hot

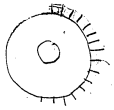
35° made the
No 12 wire for main
wires on the Columbia
as warm as % of cotton
the paint

50 Meters about

218 Faradic machines

~~Let n = no. coils~~

Let n' = no. ~~commutator~~ turns



$R = f(n)$

$R \propto \frac{1}{\text{cross section}}$

$R \propto \frac{\text{length}}{\text{cross section}}$

length $\propto$ ~~no. commutator~~ no. turns

cross section $\propto \frac{1}{\text{no. turns}}$

219

$R \propto n^2$ no

~~$R \propto n^3$~~

If depth wire is varied so that

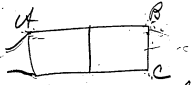
cross section $\propto \frac{1}{(\text{no. turns})^2}$

the

$R \propto n^3$

220

E. M. F. is proportional to the length of wire passed through the field



Let ~~la~~ AB = length armature

$$E.M.F \propto A.B.$$

n being constant

$$R \propto AB + BC$$

n being constant

$$R^2 = \frac{3}{8} \quad \frac{3}{2}$$

221

E.M.F constant.

AB variable

$$n \propto \frac{1}{AB}$$

$$R \propto n^2 \propto \frac{1}{AB^2}$$

$$A \propto \frac{1}{n^2}$$

$$R \propto n^2 \propto \frac{1}{AB^2}$$

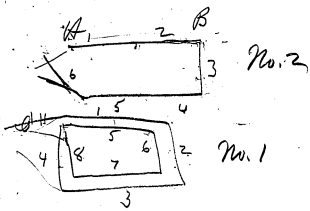
$$R \propto \frac{AB + BC}{at \neq b.e}$$

Cross section $\propto \frac{1}{n}$

$$R^2 \propto \frac{AB + BC}{at \neq b.e} \quad \frac{AB^2}{at^2}$$

AB = nat

222



No 2 $\frac{6}{8}$ length No. 1

No 2 with $\frac{1}{2}$ resistance No. 1 per foot

No 2 $\frac{6}{8} \times \frac{1}{2} = \frac{3}{8}$ resistance of No. 1

$$R \propto \frac{1}{AB^2}$$

$$A = 2$$

$$R \propto \frac{1}{4}$$

AB = active portion

BC = inert

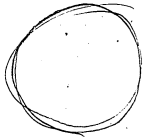
$$R^2 \propto \frac{\frac{AB + BC}{ab + bc}}{\frac{AB^2}{ab^2}}$$

$AB = 2ab$ $BC = bc$

$$R^2 \propto \frac{\frac{2ab + bc}{ab + bc}}{4}$$

$$ab = bc$$

$$R \propto \frac{\frac{3}{2}}{4} = \frac{3}{8}$$



Diameter varies

$E.M.F. = f(d)$

in fixing constant

$E.M.F. \propto n$

in same machine

same diameter

$E.M.F. \propto n \times \phi B$

$E.M.F. \propto$ speed

$E.M.F. = f$ (strength field)

strength $= f($

Thomas A. Edison